Do Museums Innovate in the Conservation and Restoration of Artwork? Differences between Countries

¿Innovan los museos en la Conservación y Restauración de obras de arte? Diferencias entre países

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Abstract: This paper examines the types of artwork restoration innovation that museums undertake, and how their knowledge bases influence these innovations. The study is based on a sample derived from a survey of 167 museums in 43 countries, with 90 of the museums having a restoration and conservation department. The sample selected for this paper includes 59 museums from nine countries: South Africa, the United States, Austria, Germany, Norway, Poland, Spain, Switzerland and the United Kingdom. Two important conclusions can be inferred from the results obtained in this paper. The first is that museums in these nine countries do innovate in the restoration and conservation of artwork. The second is that innovation performance, and the works that museums are able to restore, depend on the combination of symbolic, analytical and synthetic knowledge bases.

Keywords: creative industries, innovation, artwork restoration, museums

Resumen: Este artículo examina los tipos de innovación que llevan a cabo los museos en la restauración de obras de arte, así como la influencia de las bases de conocimiento en dichas innovaciones. Los datos proceden de una encuesta respondida por 167 museos de 43 países, de los que 90 tienen departamento de conservación y restauración. La muestra para este artículo incluye a 59 museos de 9 países: Sudáfrica, Estados Unidos, Austria, Alemania, Noruega, Polonia, España, Suiza y Reino Unido. El artículo ofrece dos conclusiones importantes. La primera es que los museos de estos nueve países innovan en la restauración y conservación de obras de arte. La segunda, que los resultados de la innovación, así como los trabajos que los museos restauran o son capaces de restaurar, dependen de la combinación de las bases de conocimiento simbólica, analítica y sintética. Esta segunda conclusión representa un avance importante en el análisis de las industrias creativas y culturales, en las que el conocimiento simbólico es visto como una característica distintiva.

Palabras clave: industrias creativas, innovación, obras de arte, restauración, museos.

1. Introduction

Literature about innovation in museums is scarce. The reason may be linked to the viewpoint that assumes that the arts are less innovative because of their dependence on subsidies (Stam et al. 2008). However, Garrido and Camarero, (2010) study museums in three European countries – Spain, France and the United Kingdom – and find that they innovate in their organization, technology and products.

The tendency to focus on innovation products is widespread in the creative and cultural industries, and authors have given different names to this: *aesthetic* (Alcaide-Marzal and Tortajada-Esparza. 2007), *stylistic* (Cappetta et al. 2006), *soft* (Stoneman 2010) and *artistic* (Gallenson, 2008) innovation. However, process innovation, the innovation which occurs in restoration departments, has not been analysed. This paper tries to cover this gap.

On the other hand, the literature about qualifications (knowledge bases) and skills in the creative industries is focused on geographical location (Dolfman et al. 2007; Throsby 2008; Asheim and Hansen 2009; Acs and Megyesi 2009; Markusen 2010; Andersen et al. 2010). There is a lack of studies with a micro-level perspective about creative industries. History reveals the research into physics and chemistry which was applied to artwork restoration in the 18th and 19th centuries (Moreira, 2008). Therefore, symbolic and analytical skills have coexisted in museums since restoration departments were developed. This paper analyses the existence of specific skills in each museum restoration department and their effect on innovation performance.

The creative activity that we analyse in this paper, artwork restoration and conservation by museums, is included in NACE 9003 (Artistic creation), while the other activities related to museums are included in NACE 91 (Libraries, archives, museums and other cultural activities). The relevance of studying NACE 90 (Creative, arts and entertainment activities) is that, independently of Markusen's (2010) assertion –"jobs in cultural industries are not synonymous with jobs in cultural occupations" – the average number of employees covered by this NACE is about 5% of the total NACE employees in the EU27 and Euro areas.

The outline that we have used in this paper is as follows: in Sections 2 and 3 we briefly summarize the recent basic theory on the study of innovation in the Arts & Cultural sector. In Section 4, we discuss the empirical study of innovation in museum restoration departments; we set out the data extracted from the survey, the variables and the methodology used for the study, as well as the results obtained. Our conclusions can be found in Section 5.

2. The Conservation and Restoration of Artwork as a Creative Industry

When the Department for Culture, Media and Sport, DCMS (2009) defined creative industries (advertising, architecture, art and antiques markets, computer and video games, crafts, design, designer fashion, film and video, music, the performing arts, publishing, software, television and radio), the heritage sector (archives, museums, libraries, tourism and sport) was not included. However, other authors and organizations have claimed that heritage activities are also creative (UNCTAD 2010). De-Miguel-Molina et al. (2012a) verify that the majority of sectors included in the creative industries are service industries and that they are especially knowledge-intensive services. Table 1 contains the creative services activities using NACE Rev 2. Additionally, a compilation of studies about innovation under each NACE code is included in Table 1.

The restoration of artwork such as paintings etc. is an activity included in NACE 90, which is entitled

Table 1
Creative services and innovation

		Creative Services NACEs	Literature about innovation in the NACE
High-tech knowledge-intensive services (HTKIS)	59	Motion picture, video and television programme production, sound recording and music publishing activities	— Müller et al. 2009 — Stoneman, 2009 — Davis, 2009 — Klein, 2011
	60	Programming and broadcasting activities	— Miles and Green, 2008
	62	Computer programming, consultancy and related activities	— Miles and Green, 2008 — Müller et al. 2009 — Stoneman, 2009 — Abreu et al. 2010
	72	Scientific research and development	— Abreu et al. 2010
Other knowledge-intensive services (OKIS)	58	Publishing activities	— Müller et al. 2009 — Stoneman, 2009
	71	Architectural and engineering activities; technical testing and analysis	— Kloosterman, 2008 — Müller et al. 2009 — Abreu et al. 2010
	73	Advertising and market research	— Miles and Green, 2008 — Müller et al. 2009 — Abreu et al. 2010
	74	Other professional, scientific and technical activities (design, photography)	— Miles and Green, 2008 — Sunley et al. 2008 — Müller et al., 2009
	90	Creative, arts and entertainment activities (NACE 90.03 includes the restoration of works of art such as paintings etc.)	— Müller et al. 2009 (performing arts)
	91	Libraries, archives, museums and other cultural activities	— Garrido and Camarero, 2010
	93	Sports activities, and amusement and recreation activities	

Source: Compiled by authors from literature sources

"Creative, arts and entertainment activities". As a result, we can state that this activity is considered to be a creative activity in national statistics.

3. Innovation in the Arts & Cultural Sector

Innovation has traditionally been associated with industries based on science and technology (Cunningham and Higgs, 2009). However, authors have tried to contextualize innovation in the creative industries, using different descriptions like *aesthetic* (Alcaide-Marzal and Tortajada-Esparza, 2007), *stylistic* (Cappetta et al. 2006) and *soft* (Stoneman, 2010). In every case, innovation is focused on changes in the appearance of the product. Kloosterman, (2008) confirms that, in general, innovation in the cultural industries is mostly product innovation.

In the art segment, Gallenson, (2008) uses the term "artistic innovation" for innovation related to advances developed by artists. But, despite the efforts to explain the peculiarities in the creative industries, literature about innovation in the arts and cultural sector is also rare, as Bakhshi and Throsby, (2010) point out. The consequence of this deficiency is that there is no clear definition of innovation as applied to arts organizations. The literature mentions the specific characteristics that differentiate the arts and culture sectors from other creative industries: their not-for-profit objectives and their service of a broader social purpose.

Following Bakhshi and Throsby, (2010), who indicate that there is no clear definition of innovation when applied to arts organizations, we explain what we mean by innovation in our study (this explanation was included in the survey we sent to museums):

- *By innovation we mean anything that involves an advance or improvement, whether it is incremental (small improvements) or radical (improvements that completely change the way in which works are examined and analysed or conservation and restoration processes), which generates:*

- *An intermediate product (tools, technologies or materials) that facilitates or enhances examination, analysis, conservation and restoration. For example, including technological advances in other sectors, such as nanotechnology, in restoration.*

- *An increase in the speed of examination, analysis, conservation and restoration. For example, a database to enable swift identification of pictures and painters.*

- *An increase in the quality or accuracy of the examination, analysis, conservation and restoration process. For example, new systems for accurately identifying age, the composition of the mounting or substrate and colours (the innovation would be the new systems used, not the "discovery" of the colours used by the artist).*

The innovation must be new or an improvement for your museum, but does not have to be new in your sector or market. It does not matter whether the innovation was originally developed by your museum or by other museums, institutes or companies.

What Gallenson, (2008) terms artistic innovation, Bakhshi and Throsby, (2010) refer to as "artform development". However, innovation in restoration and conservation is more connected with the second type of innovation identified by Bakhshi and Throsby, (2010): innovation in value creation. The value refers to the benefit obtained for a person who looks, for example, at the restored copy of La Gioconda in the Prado Museum following the recovery of the landscape beneath the black background. This kind of innovation is similar to those described as aesthetic, stylistic or soft.

But in the restoration procedure, innovation in processes may improve the appearance, which adds value to the painting. Innovation in processes may occur in some of the four steps followed by curators in their work: examination, analysis, conservation and restoration. Consequently, innovations in restoration are located both in processes and in products. In the empirical analysis of this paper, we focus on process innovations.

In the examination and analysis stages, required in both conservation and restoration, the use of advanced technologies can be observed in some museums: electron microscopy, X-ray diffraction, micro-Raman spectroscopy and gas chromatography-mass spectrometry (de-Miguel-Molina et al. 2012b). The difference between conservation and restoration is based on the aim. While conservation tries to "maximize the endurance or minimize the deterioration of an object through time, with as little change to the object as possible, restoration tries to return it to an earlier condition or appearance, through repair, renovation, reconditioning or other intervention" (Lord and Lord, 2008). Papini and Persiani, (2004) indicate that exhibition and conservation are the main activities in a museum, and are essential to preserve its collection. Kotler et al. (2008) mention acquisition,

conservation and exhibition as the objectives of a museum. Museum restoration laboratories and departments were set up in the 19th century. With the Industrial Revolution, the transformation of cities and the funding of collections by the bourgeoisie, contemporary bases for conservation and restoration were established (Moreira, 2008).

The importance of innovation in the creative sectors has been mentioned by authors like Bakhshi and McVittie, (2009), who state that creative products are inputs that have an impact on innovation in other sectors. Moreover, they conclude that supply-chain linkages with the creative sector generate knowledge transfer to other sectors of the economy. Regarding this characteristic, Sunley et al. (2008), however, detect that creative industries "such as design, advertising and architecture are rather different than music, performing arts and film". Nevertheless, the association between knowledge and innovation has been detected in the creative industries by Müller et al. (2009). These authors confirm what Caloghirou et al. (2004) and Vega-Jurado et al. (2008) indicated about knowledge bases (qualifications) in science and technology as determinants of firms' innovation.

This approach can be perceived in the restoration and conservation departments of museums, as they undertake different activities that require specific qualifications. For example, the restoration department in the Prado Museum (Sedano Espín, 2011) is divided into three sub-areas: restoration (painting, sculpture, etc.), technical documentation (reflectography and radiography) and laboratory testing (chemistry and biology). Each sub-area needs the presence of different knowledge bases, that is, graduates in the areas of restoration (symbolic), science (analytical) and engineering (synthetic).

4. Empirical Analysis of Innovation in the Conservation and Restoration of Artworks in Museums

4.1. Sample and variables

Data about artwork restoration innovation were obtained from a survey undertaken in 167 museums in 43 countries on the five continents (Table 2). For this paper, because the aim is to compare countries, we selected museums located in countries for which there were a minimum of three responses. Therefore, we studied 59 museums from nine countries: South Africa, the United States, Austria, Germany, Norway, Poland, Spain, Switzerland and the United Kingdom.

The questionnaire was an adaptation, for the artwork restoration sector, of two Community Innovation Surveys[1] (CIS) which were drawn up following the recommendations of the Oslo Manual (OECD 2005).

The adaptation of the survey was guided by advice from the conservation and restoration departments at some of the leading Spanish museums and restoration institutes and several German museums[2]. The adaptation and design of the final version took a year.

The main difficulties we encountered in selecting the sample and obtaining information about who to contact were that in many cases directors and officers changed between when we drew up our list of museums and when we started sending out emails and letters, and there were also changes in websites, contact addresses and postal addresses during that time. The questionnaires were translated into a number of languages including English, French, Italian and German.

The requirement in selecting museums for the sample was that they should have paintings in their permanent collection. This is because the study is part of a research project focused mainly on painting[3]. As a result, museums which did not have a permanent collection, or did not have paintings, were excluded. The final sample consisted of 900 museums in 43 countries, from which 167 responses were received, i.e. 18.55% of the sample.

In the first round we received 100 replies, and we received another 67 in our second round. We have received a few more replies since then, although they are not included in the findings of this paper. The surveys were sent in two rounds between December 2010 and July 2011. We started to receive replies in January 2011. In this paper we consider replies received up to October 2011.

Variables (Table 3) were measured using questions from the survey given to the museums' restoration and conservation departments, and are divided into

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Table 2

Summary of responses received and countries where the museums are located

Continent	Responses	Countries
Europe	112 from 29 countries (67%)	Austria, Belgium, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey (European area), United Kingdom
America	39 from 8 countries (23%)	Argentina, Brazil, Canada, Chile, Costa Rica, El Salvador, Guatemala, United States
Asia	7 from 3 countries (4%)	Japan, Republic of Korea, Taiwan
Africa	3 from 1 country (2%)	South Africa
Oceania	6 from 2 countries (4%)	Australia, New Zealand
TOTAL	**167 from 43 countries**	

Compiled by the authors using data from the survey.

Table 3

Variables used in the analysis of innovation in the restoration and conservation of artworks

Variables	Measure
1. Know-how	A) Restore works for others: other museums, public institutions, private institutions, the Church B) Skills (works that departments restore or are able to restore): W1: Easel paintings W2: Mural paintings W3: Gilding and altarpieces W4: Polychrome sculptures W5: Palaeontology W6: Works in stone W7: Textiles W8: Metal and gold or silverware W9: Ceramics W10: Furniture W11: Glass W12: Photographs W13: Archive documents W14: Film and video art W15: Other
3. Human capital	Knowledge bases (Qualifications): Q1: Fine arts … *Symbolic Knowledge* Q2: Fine arts (specialising in restoration) … *Symbolic Knowledge* Q3: Conservation and restoration… *Symbolic Knowledge* Q4: Chemistry… *Analytic Knowledge* Q5: Physics… *Analytic Knowledge* Q6: Biology… *Analytic Knowledge* Q7: Engineering… *Synthetic Knowledge* Q8: History Q9: Art history Q10: Photography… *Symbolic Knowledge* Q11: Other
4. Innovation	Types of innovations: I1: in methods and instruments used to examine and analyse art objects I2: in products and reagents used to examine and analyse art objects I3: in techniques or procedures used in restoration I4: in tools or instruments used in restoration I5: in consumables (glazes, solvents, biocides, etc.) used in restoration I6: in displaying works in exhibition halls (in terms of the microclimate, light, mounting or substrate, etc.) I7: in storing works in storage rooms I8: in transporting works

three groups: **know-how**, **human capital** and **innovation**. The first of these includes variables that show whether the museum carries out restoration for others, and which works it can restore (skills). Human capital includes the qualifications of the specialists working in the restoration department. The innovation variable refers to the innovations carried out by the museum over the previous three years, the period recommended by the Oslo Manual (OECD 2005).

4.2. Results

Below are the main results of the survey, which include the results for the variables on an individual basis, depending on the geographic location of the museum, taking into consideration only those museums which have a restoration and conservation department.

Figure 1 shows that 100% of these museums had carried out restoration work in the previous three years. In the figure, a difference can be observed for Spanish museums related to the restoration of works in temporary exhibitions, because the cost of the restoration is paid by the museum.

Figure 2 shows how important restoration is for museums, as it shows that even museums which have a restoration department outsourced restoration work.

Looking at where the work is outsourced, the results in Table 4 show that restoration companies get most of the work outsourced by museums. Outsourcing to restoration institutes occurs in South Africa and Spain; outsourcing to universities takes place in the United Kingdom and Austria. In view of Table 4, the patterns by country are:

— South Africa: museums outsource to other museums, restoration institutes and restoration companies.

— USA: museums outsource to other museums, restoration institutes and restoration companies.

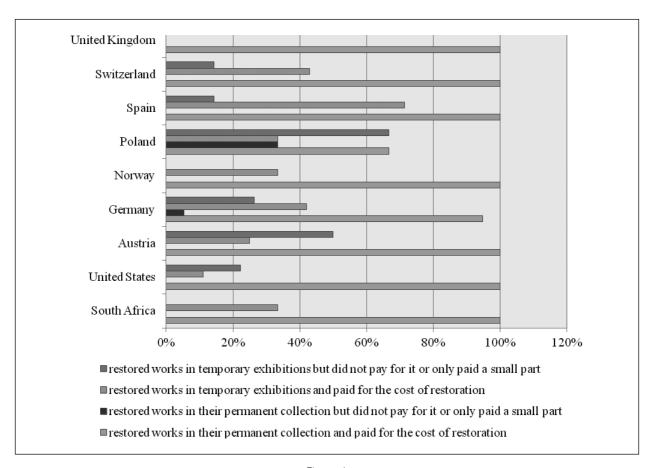— Austria: museums outsource to restoration companies and universities.

Figure 1
Museums that had carried out restoration work in the previous 3 years.
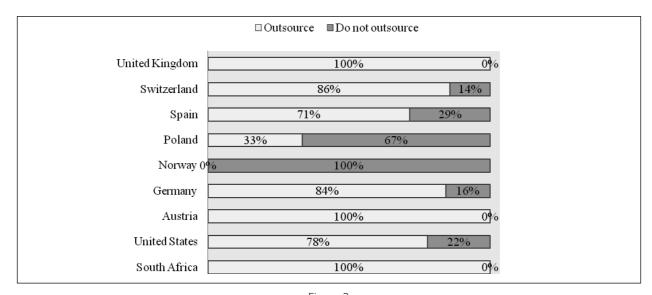Compiled by the authors using data from the survey

Figure 2

Museums that outsourced restoration work by country (percentages). Compiled by the authors using data from the survey

Table 4
Destinations of outsourced restoration work

Country	Outsourced to			
	Other museums (%)	Restoration institutes (%)	Restoration companies (%)	Universities (%)
South Africa	33	67	100	0
United States	11	11	56	0
Austria	0	0	100	50
Germany	0	0	84	11
Norway	0	0	0	0
Poland	33	33	33	33
Spain	0	43	57	0
Switzerland	14	0	86	29
United Kingdom	0	50	100	100

Compiled by the authors using data from the survey. The row totals may be higher than 100 because calculations are based on all the museums in the country.

— Germany: museums outsource to restoration companies and universities.

— Norway: museums do not outsource.

— Poland: museums outsource to other museums, restoration institutes, restoration companies and universities.

— Spain: museums outsource to restoration institutes and companies.

— Switzerland: museums outsource to other museums, restoration companies and universities.

— United Kingdom: museums outsource to restoration institutes, restoration companies and universities.

Know-how variables include restoration that museums do for other institutions and the museums' skills for restoration and conservation (works). With respect to the first variable, Figure 3 shows that a higher proportion of museums in the United Kingdom, Switzerland, Poland and South Africa perform restoration work for others than do not, while in Spain, Norway, Germany and the USA, the reverse is the case.

Concerning the works museums restore or are able to restore, Table 5 shows that museums that can restore easel paintings also do a significant amount of other work. These include, for example, work on gilding and altarpieces (United Kingdom and Poland), sculptures (Spain and Poland), stone (USA and Poland), metal and gold or silverware (USA), and ceramics (USA and Spain).

Table 5
Work which museums restore or are able to restore – total responses

WORK	South Africa (%)	United States (%)	Austria (%)	Germany (%)	Norway (%)	Poland (%)	Spain (%)	Switzerland (%)	United Kingdom (%)
Easel paintings	67	78	75	95	67	100	100	71	100
Mural paintings	0	67	0	11	0	33	57	14	50
Gilding and altarpieces	0	78	0	42	0	100	86	14	100
Polychrome sculptures	0	78	25	68	0	100	100	57	75
Palaeontology	0	0	0	16	0	0	14	14	25
Works in stone	33	89	25	11	0	100	43	0	75
Textiles	0	44	25	11	0	100	14	29	25
Metal and gold or silverware	33	89	50	21	0	100	29	14	50
Ceramics	67	89	0	16	0	100	71	14	50
Furniture	0	78	0	21	0	100	57	14	50
Glass	33	78	0	16	0	100	29	14	50
Photographs	0	56	50	21	67	67	57	14	75
Archive documents	0	67	25	26	33	100	57	29	100
Film and video art	0	22	0	11	0	0	14	0	0
Other	33	44	50	63	33	67	14	29	50

Compiled by the authors using data from the survey. The column totals may be higher than 100 because calculations are based on all the museums in the country
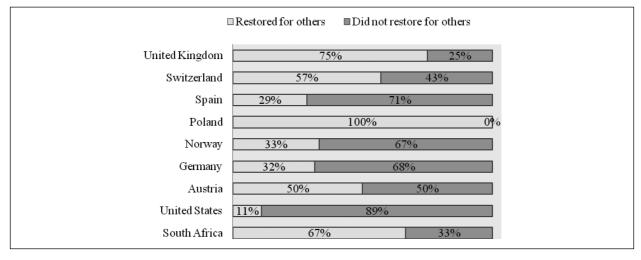

Figure 3
Museums that restored for others (percentages and countries). Compiled by the authors using data from the survey

In relation to the human capital variable, the survey results can be used to obtain an average figure for the degree to which museums are multidisciplinary, by geographic area. Up to eleven different qualifications were provided as options in the survey, and Figure 4 shows that the most multidisciplinary teams are in the United Kingdom with, on average, almost six different qualifications in their museums, while the least multidisciplinary are in Norway, Germany and Austria.

Table 6 shows the countries in which can be found the types of knowledge proposed as important by different authors (Caloghirou et al. (2004) and Vega-Jurado et al. (2008) for innovation, and Asheim, (2007) and Asheim and Hansen (2009) for creative activities). The results for the museums surveyed illustrate that in this creative activity the three types of knowledge (science, engineering and art) may be present at the same time. However, this convergence only appears in three countries: Germany, Poland and the United Kingdom. In the USA, Spain and Switzerland, museums only have analytical and symbolic knowledge (scientists and artists), while in South Africa, Austria and Norway they only have symbolic knowledge (artists).

Finally, innovations were undertaken by museums in every country, although the percentage of museums which did not innovate is higher in Spain and South Africa. In contrast, all the museums in the United Kingdom, the USA, Switzerland and Poland innovated in conservation and restoration (Figure 5).

Table 6
Knowledge bases (qualifications) in museum restoration and conservation departments – percentage of museums with specialists by knowledge base

Country	Symbolic Knowledge* Base (%)	Analytical Knowledge** Base (%)	Synthetic Knowledge*** Base (%)
South Africa	100	0	0
United States	100	78	0
Austria	100	0	0
Germany	100	11	5
Norway	100	0	0
Poland	100	67	67
Spain	100	29	0
Switzerland	100	29	0
United Kingdom	100	75	25

* Fine Arts, Fine Arts (specialising in restoration), Conservation & Restoration, Photography.
** Chemistry, Physics, Biology.
*** Engineering.
Compiled by the authors using data from the survey. The row totals may be higher than 100 because calculations are based on all the museums in the country.
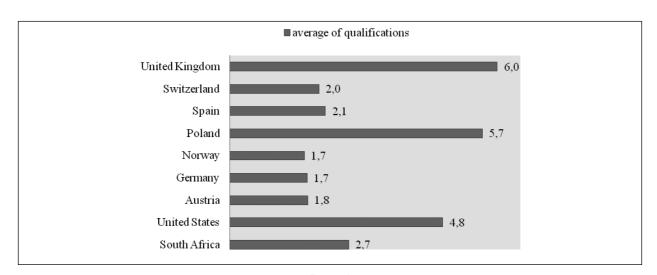

Figure 4
Average number of different types of qualification in museums by country. Compiled by the authors using data from the survey
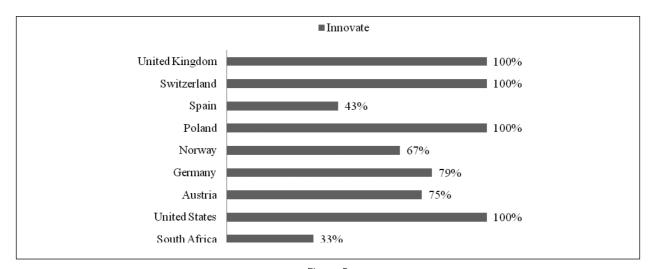
Figure 5

Museums which carried out innovation (percentage). Compiled by the authors using data from the survey

The results in Table 7 indicate that museums in all the countries have carried out innovation. The table shows that the museums in the USA have, in proportion, carried out more type 1 (methods and instruments used to examine and analyse art objects) and type 6 (displaying works in exhibition halls) innovations. Museums in Spain have carried out type 1 (methods and instruments used to examine and analyse art objects), type 2 (products and reagents used to examine and analyse art objects), type 3 (techniques or procedures used in restoration), type

5 (consumables used in restoration) and type 6 (displaying works in exhibition halls) innovation. Switzerland carried out type 3 (techniques or procedures used in restoration), type 4 (tools or instruments used in restoration) and type 7 (storing works in storage rooms) innovation. The United Kingdom carried out type 1 (methods and instruments used to examine and analyse art objects), type 3 (techniques or procedures used in restoration) and type 6 (displaying works in exhibition halls) innovation.

Table 7

Museums which carried out innovations in restoration – percentages

Country	Number of museums which carried out innovations in…							
	I1 (%)	I2 (%)	I3 (%)	I4 (%)	I5 (%)	I6 (%)	I7 (%)	I8 (%)
South Africa	33	0	33	0	0	33	33	33
United States	78	56	67	67	33	78	33	22
Austria	25	0	50	75	0	50	50	25
Germany	26	16	58	21	26	58	37	37
Norway	67	0	33	67	33	67	33	33
Poland	100	67	100	100	100	100	33	67
Spain	86	71	71	57	86	100	57	43
Switzerland	57	29	71	86	29	43	71	43
United Kingdom	75	0	75	50	25	75	50	50

I1: in methods and instruments used to examine and analyse art objects; I2: in products and reagents used to examine and analyse art objects; I3: in techniques or procedures used in restoration; I4: in tools or instruments used in restoration; I5: in consumables (glazes, solvents, biocides, etc.) used in restoration; I6: in displaying works in exhibition halls (in terms of the microclimate, light, mounting or substrate, etc.); I7: in storing works in storage rooms; I8: in transporting works
Compiled by the authors using data from the survey. The row totals may be higher than 100 because calculations are based on all the museums in the country

Following Caloghirou et al. (2004) and Vega-Jurado et al. (2008), we are going to check whether the knowledge bases (qualifications) in science and technology have an influence on the museums' innovation. For this purpose, and considering that the data are counts, we use the non-parametric test of Mann-Whitney. The two groups are: 1) museums which have only a symbolic knowledge base; and 2) museums which also have analytical and/or synthetic knowledge bases. The results in Table 8 show that knowledge bases do have an impact, not only on the innovations that museums undertook, but also on the works that museums restore or are able to restore. However, the knowledge bases have no relation to the outsourcing of artwork restoration or on restoring artwork for others. In the case of outsourcing, one reason may be that, when museums have the qualifications and skills, they do not need to outsource restoration. With reference to restoration for others, wider research would be necessary in order to detect which factors determine why a museum restores artwork for other institutions.

Furthermore, the reasons museums said were very important in relation to decisions to stop innovation projects or leave them incomplete (Figure 6) in the previous three years were economic, especially in Spain. The main reason was the lack of funding in Spain, Poland and Germany, while in Switzerland it was the cost of innovation. Lack of qualified personnel was an important cause for museums in South Africa, Switzerland and Norway. However, lack of information about technologies does not appear as an important limit for innovation.

Table 8
Influence of knowledge bases on innovation and other variables

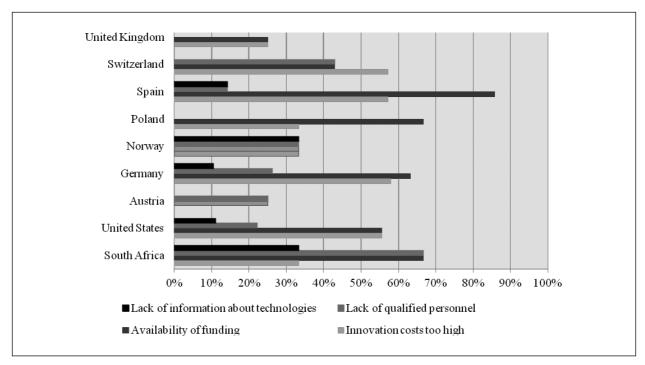| Grouping Variable: KnowledgeBase	Variables			
	Total Outsourcing	Total Works (skills)	Total Restoration for others	Total Innovations
Mann-Whitney U	330.500	138.000	340.500	206.500
Asymp. Sig. (2-tailed)	.384	.000	.474	.005

Compiled by the authors using data from the survey.

Figure 6
Reasons which explain the decision to stop or leave innovation projects incomplete. Compiled by the authors using data from the survey

5.   Conclusions

In the same way as in other creative sectors, one of the main features of the sector analysed in this paper, the restoration of artworks, is its symbolic nature (Cappetta and Cillo, 2008, Cunningham and Higgs, 2009), i.e. its ability to create symbolic value. This paper studies innovation in museums with a framework which does not ignore this symbolic feature. Likewise, innovations in the arts and cultural sectors tend to be centred on products, so we have focused on processes.

Data were obtained from a survey of 167 museums in 43 countries, although we centre our attention on a comparison of museums located in nine countries (South Africa, the United States, Austria, Germany, Norway, Poland, Spain, Switzerland and the United Kingdom) which have a restoration department.

Among the variables selected, those related to internal resources (qualifications and skills) have been taken into account (Caloghirou et al. 2004, Tether and Tajar, 2008). The results show the impact that qualifications have both on skills and on innovation performance, as we explain below.

The results make it possible to answer to some questions about the restoration and conservation of artwork: the areas in which museums innovate, their human capital, and how this human capital influences innovation. The innovations carried out by the museums responding to the survey were mainly in the methods and instruments used to examine and analyse art objects, the techniques and procedures used in restoration, the tools or instruments used in restoration, and the display of works in exhibition halls. In addition, the innovation performance of these museums was higher if they had more specialists in the fields of analytical, synthetic and symbolic knowledge. The coexistence of the three knowledge bases is an important feature of museums, although the symbolic base predominates. Until now, there had been no study analysing the importance of the three knowledge bases for the improvement of innovation performance in this sector. This is one of the main contributions of this paper to academic debate.

On the other hand, having human capital allows museums not to depend on other institutions to restore their artworks. Nevertheless, when they need to outsource a restoration, they usually turn to specialist companies. The findings about the impact that human resources have on the innovation performance of

museums, as of other sectors, should be considered by those responsible for museum management.

The limitations of the research are due to the restriction in the selection of museums to those having paintings in their permanent collections. A wider survey could give more information about innovation in the museums which we did not take into account. Moreover, the number of answers from museums was low for some countries and continents.

Policymakers should reconsider the viewpoint that the arts are less innovative because of their dependence on subsidies (Stam at al. 2008). The sector analysed makes use of advanced science and technology (de-Miguel-Molina et al. 2012b), and employs scientists and engineers, all of which may tend to increase innovation.

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